(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 136 042 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of patent specification: **08.01.92** (51) Int. Cl.[5]: **A23B 7/148**, B65D 88/74

(21) Application number: **84305628.4**

(22) Date of filing: **17.08.84**

(54) **Improvements in and/or relating to the carriage of comestibles and in particular to containers and related means and methods suitable for such purposes.**

(30) Priority: **01.09.83 NZ 205453**

(43) Date of publication of application:
03.04.85 Bulletin 85/14

(45) Publication of the grant of the patent:
08.01.92 Bulletin 92/02

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

(56) References cited:

CH-A- 419 815	DD-A- 130 306
FR-A- 1 435 917	GB-A- 1 198 354
US-A- 3 102 780	US-A- 3 307 618
US-A- 3 360 380	US-A- 3 508 881
US-A- 4 142 372	US-A-32 691 33

TECHNISCHE RUNDSCHAU SULZER, vol. 48, no. 2, 1966, pages 100-102, GEBRÜDER SULZER AG CH 8401 WINTERTHUR; G. SCHOBERTH: "CO2-Absorber zur Lagerung von Äpfeln unter kontrollierter Atmosphäre"

(73) Proprietor: **TRANSFRESH CORPORATION**
607 Brunken Avenue
Salinas California 93902(US)

(72) Inventor: **Lovegrove, John Robert**
12 Orakei Road
Remuera Auckland 5(NZ)
Inventor: **Harris, Samuel**
183 Archers Road
Takapuna Auckland(NZ)

(74) Representative: **Ayers, Martyn Lewis Stanley et al**
J.A. KEMP & CO. 14 South Square Gray's Inn
London, WC1R 5EU(GB)

EP 0 136 042 B1

Description

The present invention relates primarily to improvements in and/or relating to the carriage of comestibles and/or plants whether cut or not and in particular to containers (eg. of the sea transport type) and related means and methods suitable for such purpose.

Many countries because of their geographical position are in an unenviable position owing to the large distance over which comestibles must be shipped and many of the answers that deal with the shorter passages involved in freighting, for example, fruit and/or vegetables are not always appropriate.

With many foodstuffs and in particular we refer to fruit and vegetables there is a desire to avoid freezing so as not to lower the quality of the end product in the hands of the ultimate consumer and while air freighting is an answer in relation to highly valued food items it is not appropriate for most bulk food items. In any event if an alternative form of freighting was available without detracting from the quality of the comestible such alternative would no doubt be cheaper than air freighting and be able to carry greater volumes.

It is therefore an object of the present invention to provide means and/or methods which will go at least some way to meeting the above mentioned desiderata or which will at least provide the public with a useful choice.

Attempts have been made in the past to provide systems which go at least some way to overcoming the difficulties but which of themselves are not totally appropriate for the longer distances where the comestibles must be maintained for much longer periods. Some systems take into account that certain fruits or vegetables can be sustained for longer than usual periods at non-freezing but nevertheless refrigerated temperatures when maintained at an atmosphere considered conducive for the preservation of the fruit, vegetable or plants during shipping.

One such system is known as the "NITROL" system. In this respect we refer to U.S. Patent Specification No. 3239360. This system relies on an ability to periodically purge the atmosphere with nitrogen based on controls which respond to the oxygen level within the environment of the shipping container. The only control therefore is based on oxygen level and a stopping and starting of a nitrogen purge system using liquid nitrogen in a container designed to allow leakage of gas. Such a system if used for very long shipping distances would required very large quantities of nitrogen.

Another system that has been available is the "TECTROL" system which has been known since about 1960 and has been associated with Transfresh Corporation of the United States. This system relies on a sealing of the container using a seal inside of the container doors. The environment is then flushed with a premixed gas (trade name "TECTROL"). This sytem differs from the NITROL system in that there is no monitoring or control of the environment during shipping other than of course in respect of temperature. The balance between oxygen and carbon dioxide which is critical to the well-being of fruit and/or vegetables is controlled rather arbitrarily by inserting into the container prior to its being sealed quantities of hydrated lime to absorb excessive amounts of carbon dioxide. Since the comestible can be ruined if there is not sufficient oxygen a bleed hole in the container (normally in a flushing valve) is provided to prevent oxygen depletion as a result of the respiration of the product which converts oxygen within the environment into carbon dioxide. The carbon dioxide and oxygen control is not rigidly controlled to a pre-set level.

It should be realised that fruit and vegetables require oxygen if they are to remain fresh since fruit and vegetables continue to respire after harvest. It is the aim of the present invention to make them live more slowly in a controlled low oxygen atmosphere and preferably with control of at least one other gas. Live plants (whether potted or cut) respire and hence similar factors arise.

The present invention relates to a method of transporting which has application for not only long distance transportation but also for shorter distance transportation where the quality of the comestible is a prime factor. The present invention has advantage over pre-existing systems in that

1. Conventional shipping containers can be used with only a minimum of modification
2. While at a loading station flushing with a gas high in nitrogen can be carried out where a low oxygen environment is required there is no necessity for the provision of gas bottles with the container since oxygen control in transit is controlled by the infusion of ambient air under the control of an oxygen monitor and the carbon dioxide level is controlled by a scrubber under the control of a monitor and
3. It is not necessary to provide a complete seal of the environment - it merely being necessary to ensure the leakage route is not such as to allow the unforced infusion of ambient air into the environment so as to provide more oxygen than is required by the comestibles and preferably also to ensure the loss of atmosphere through such leakage route of carbon dioxide from the container environment is not at a rate greater than is produced by the comestibles.

US-3508881 on which is based the prior art portions of claims 1 and 9 discloses transporting a quantity of comestible which may be subject to degradation as a result of respiration during transportation in a container wherein the container is flushed to reduce the oxygen level in the container atmosphere, and the container is transported with the respiring comestible therein while monitoring the oxygen and carbon dioxide levels within said container and adjusting the oxygen and carbon dioxide levels as necessary in response to such monitoring towards an optimum or predetermined value or range of values. The system is basically a closed recirculating system with a positive control of the gas levels as required.

The present invention as characterised in claims 1 and 9, makes use of controlled partial sealing of the container with the requirements to supply air being kept to a minimum due to the leakage of air into the container but in an amount to ensure that less oxygen from the ambient air can diffuse into the container than is required for respiration by the respiring comestible. The partial sealing of the container is also such as to ensure the production of carbon dioxide by the respiring comestible as a result of the respiration is greater than can diffuse from the container whereby the sole source of carbon dioxide during continuing use of the container to maintain the carbon dioxide level within said container is that carbon dioxide which is produced by respiration, the excess carbon dioxide being scrubbed as necessary to maintain an optimum or predetermined value or range of values.

US-A-3 307 618 and DD-A-130 306 are other documents which disclose methods and apparatus for preserving comestible products in a container where the rate of deterioration of the products is reduced by controlling the rate of respiration by controlling the proportions of oxygen and carbon dioxide in the atmosphere within the container. Whilst providing apparatus for supplying and abstracting the gases as required to maintain the desired levels, they basically operate as supplying or removing gases to an enclosed atmosphere and none appreciate the possibility of making use of a controlled leakage given by partial sealing of the container whereby gas supply requirements are kept to a minimum with some, but never all, of the air requirements being provided by leakage into the container and with an amount of carbon dioxide greater than that which can leak from the container being produced by the respiration of products in the container.

Preferably a temperature monitoring system for the environment and/or atmosphere of the container and means responsive to the monitoring system to lower the temperature are provided.

One preferred form of the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a plan diagrammatic view of a shipping container in accordance with the present invention, the left hand end showing the zone which would include the control systems and include of course the refrigeration system, the right hand end showing a door seal such as is used by Transfresh Corporation and the crosses denoting an ingress and egress flushing valve substantially of a kind as is used by Transfresh Corporation save however that no bleed hole is associated therewith,

Figures 2A and 2B each show an elevation view of the container as depicted in Figure 1 showing diagrammatically the air circulation which occurs within the container as a consequence of the pressure differential caused over the evaporator (E) caused by the fan which is therebelow or thereabove, the air leaving (in Figure 2A) (or alternatively entering as shown in Figure 2B) the evaporator zone using the fluted floor which provides ducting under the load (not shown) and of course the gap above the load within the container,

Figure 3 is a diagrammatic view showing how in the preferred system in accordance with the present invention the pressure differential across the evaporator can be employed to not only provide the sampling of the environment to the controller which in the preferred form of the present invention controls both oxygen and carbon dioxide levels but also can provide the positive infusion of air into the environment when valves above and below the evaporator are provided,

Figure 4 shows in a more simplified form the arrangement of Figure 3 when the oxygen controller indicates that the oxygen level is unacceptably low and an infusion of air is desired to raise the oxygen level,

Figure 5 is a diagrammatic view of one form of arrangement to scrub carbon dioxide (or other gases) from the environment under the action of a separate fan and valves to that depicted in Figures 3 and 4, it being appreciated however that scrubbing with, for example, hydrated lime can occur even under that pressure differential if desired,

Figure 6 is a graph for a range of standard 6.4 metre (21 foot) shipping containers showing pressure decay time due to leakage expressed in minutes (for the pressure differential between the starting pressure within the container and atmospheric pressure to decay by half) against actual leakage rate (at normal ambient temperatures and at a half inch water gauge pressure) in cubic feet per hour, and

Figure 7 is a diagram of preferred container wiring,

Figure 8 is the preferred carbon dioxide and oxygen controller circuit diagram,

Figure 9 is a diagram of the controller layout, and

Figure 10 is a block diagram of the overall control system.

The present invention differs from the systems that have previously been used in that there is a positive automatic control of the oxygen and carbon dioxide content using controlled leakage between the ambient and the interior of the container to provide some of the oxygen requirement and some of the excess carbon dioxide removal. Preferred percentages of oxygen and carbon dioxide levels for specific fruits, vegetables and plants are normally in the vicinity of 1-10% by volume oxygen and 0-10% by volume carbon dioxide in order to enhance freshness at the end of shipping.

With this system in accordance with the present invention it is envisaged that a container would be provided to a grower who wishes to pack his fruit or vegetables. It is envisaged that when supplied the carbon dioxide scrubbing unit, as depicted in Figure 5, would be positioned at zone 1 or thereabouts in Figure 2A or 2B. The unit shown very simply in Figure 5 includes a bag, layer or the like of hydrated lime 2 over a support medium 3 which bag and/or support is pervious to air and above a fan or the like 4 with electrically operated control valves or the like 17. The supplier would then load his fruit, vegetables or plants and activate the refrigeration unit just before and/or after having closed the doors 5. The refrigeration unit is provided in the zone 6 and indeed the evaporator E forms part of the refrigeration unit as also does the fan 7.

The containers would then be moved promptly to a shipping depot where using an ingress port 8 and an egress port 9 the environment within the storage space 10 which includes the vegetables and/or fruit and/or plants would then be flushed by a gas high in nitrogen and low in oxygen so as to lower the oxygen content towards the desirable level. Obviously before such flushing a sealing curtain 11 would be inserted. Such a sealing curtain would be as impermeable to gas movement therethrough as possible. If desired, carbon dioxide gas would then be added to the container to the predetermined level through ports 8 and 9.

After flushing the environment would then be controlled by the controller 12 which samples preferably from an intake 13 and discharges the sample back out at 14.

The controller preferably is a controller of both oxygen and carbon dioxide. Preferably the combined oxygen-carbon dioxide tester is removable from the unit so as to ensure that in those circumstances when it is not required it can be used with other containers. Ideally the combined tester is one as supplied by G.F.G. of West Germany. If however only an oxygen control is to be utilised or if the oxygen controller is to be separate from the carbon dioxide controller preferably the controller is either a "TELEDYNE" portable oxygen analyser or one supplied by Beckman of the United States. A separate carbon dioxide controller is available from G.F.G. of West Germany.

In Figure 10 there is shown bounded by the rectangular outline (indicative of a single apparatus) various flow contol and functional aspects of the overall controlling system. The broken line serves the purpose of separating the added functions desirable for the performance of the present invention to the function of existing combined tested such as supplied by G.F.G. of West Germany. Above the broken line are shown functions of the G.F.G. tester. In such a combined tester it can be seen that a gas sample is brought into a carbon dioxide detector within the overall apparatus and a measured value signal indicative of the CO_2 level is given as an output. The gas sample then passes from the carbon dioxide detector to the oxygen detector before being returned to the environment from which it came or being discharged to waste. The oxygen detector has as an output a measured value signal indicative of the oxygen level.

Modifications to the combined tester previously described are shown below the broken line in Figure 10. These comprise the provision of a carbon dioxide controller which is to receive not only the input of the output measured value signal from the carbon dioxide detector but also a setting input whereby a manual entry can be made of a desired carbon dioxide value. The carbon dioxide controller would incude a logic capability which would enable it to compare the measured and the manually set desired value. The measured carbon dioxide value signal is compared to the desired value. If the actual measured carbon dioxide value is above the desired value a signal is then sent to the carbon dioxide scrubber to scrub the atmosphere within the container. Repeated comparsions would continue to be made. When the carbon dioxide value measured is below the desired value no signal is sent. It can be seen that there is therefore a simple means of actuation for example a fan or valves associated with a carbon dioxide scrubber.

Likewise the oxygen controller compares the measured value signal indicative of oxygen level against the oxygen desired setting input and in this case if the actual measured oxygen level is below the desired value the controller sends a signal to the oxygen infusion actuator which in the preferred form of the present invention are solenoid valves which can be opened. If the oxygen is above the desired value no signal is sent and in such a circumstance the solenoid valves remain closed, or if they had previously been opened, are closed.

It seems desirable therefore to provide a purpose built machine which embodies not only the existing components of a combined tester as indicated above the broken line in Figure 10 but also the additional controller functions described in relation to Figure 10.

A purpose built CO_2 and O_2 controller has been designed for use in controlled atmosphere produce storage in shipping containers.

The unit has two transducers. The CO_2 transducer is a thermal conductivity cell, it has four resistive filaments in a bridge configuration. The cooling effect of CO_2 gas causes a change in the resistance of one of the filaments, this change is proportional to the % CO_2 present. The O_2 fuel cell generates a potential difference proportional to the amount of O_2 present.

The controller can be set for the desired levels of O_2 and CO_2 and will maintain this set level by simple on/off control of a series of solenoids (see Figure 8) around the container.

CIRCUIT OPERATION

(a) Power Supply: Refer to Figure 8. The controller transformer has a 24V primary and 7,0,7 centre tap secondary. It is 7VA at 450 mA. The A.C. is full wave rectified by a diode bridge IC1 RB155 to give a bipolar supply with respect to the centre tap. This is then filtered by C_2 and C_3 and regulated to +5 volts (IC3,LM7805) and -5 volts (IC4, LM7905). The capacitor C1 and regulator IC1 (LM317) provide a constant current source for the CO_2 bridge. The bridge current is set to 180 mA by adjustment of the cermet RV1.

(b) CO2 Control Circuitry: The resistors R1, R2 and the cermet RV2 are for balancing the bridge. The signal across the bridge provides a differential input to a CAZ amplifier (Commutating Auto Zero) (IC5, ICL7605 Pins 17,18). This amplifier was selected for its excellent stability and sensitivity.

The CAZ amp. references the differential input signal to the voltage present on the Auto Zero pin (pin 1). The resistors R6, R7, and cermet RV4 provide zero adjustment for the CO_2 meter.

The SPAN adjustment is used to calibrate the meter M2 and adjusts the gain of the amplifier

$$G = \frac{R3 + R4 + RV3.}{R4 + RV3.}$$

The negative output of the CAZ amp. (pin 9) is low pass filtered by R5 and C11 to filter out the commutation spikes.

A comparator IC7.3, with approx. 50 mV of hystersis (R8 and R9), compares the amplified signal level (pin 9) with a negative voltage (pin 10) set by the SET point cermet RV5. As the CO_2 concentration increases the CO_2 voltage level becomes more negative. When this voltage falls below the SET voltage the comparator output (pin 8) switches high.

IC9 is an opto isolated solid state rely. As the comparator output switches high pin 3 is taken positive with respect to pin 4, this switches 24V AC through to the appropriate container solonoids as well as illuminating the OUTPUT light.

As the CO_2 concentration decreases the comparator output will switch low along with pin 3 (IC9). This disconnects the 24V AC line and switches the OUTPUT light off.

IC7.4 is a voltage follower and buffers the set point voltage or the CO_2 signal level, depending on the position of the push button switch S2. This voltage causes a current to flow through the meter M2 and generates a voltage at J3. The cermet RV6 sets the voltage on J3 for -100 mV/1% CO_2.

(c) O_2 Control Circuitry: The signal from the O_2 fuel cell is amplified by the uncompensated op.amp. IC6 (LM308). The gain or

$$SPAN = \frac{R17}{R16+RV8}.$$

The op.amp. is configured as inverting summing amplifier and adds in a voltage determined by the ZERO cermet RV7.

A comparator, (IC7.1) with approx 50 mV of hystersis (R19 and R20) compares the amplified signal with a negative voltage set by the SET point cermet RV9. As the O_2 concentration increases the O_2 voltage level becomes more negative. When this voltage falls below the SET voltage the comparator output (pin 1) switches high, this forces pin 4, IC8 to a potential similar to pin 3 and therefore breaks the 24V AC line and turns the OUTPUT light off.

As the O_2 concentration falls the comparator output will switch low causing the sold state relay to switch the 24V AC to the appropriate solenoids and to illuminate the OUTPUT light.

IC7.2 is a voltage followers and buffers the SET point voltage or the O_2 signal level - depending on the position of S1. This voltage causes a current to flow in the meter M1 and generates a voltage at J2. The cermet RV10 sets the voltage on J2 for -100m/1% O_2.

SETTING UP PROCEDURE

1) Mechanically zero both meters.
2) Disconnect the two signal arms of the CO_2 bridge, place an ammeter in series with the + side of the bridge and adjust RV1 for 180 mA. Reconnect bridge and seal the cermet.
3) Pass a sample of 0% CO_2 gas through the cells and measure the differential voltage at pins 17, 18 IC5. Adjust RV2 for OV, seal the cermet.
4) Pass a sample of 0% O_2 through the cells and adjust the ZERO cermet RV4 so the meter M_2 reads 0.
5) Pass a sample of 0% O_2 through the cells and adjust the ZERO cermet RV7 so the meter M1 reads 0.
6) Connect a voltmeter to the output BNC J2. With S1 in the SET mode adjust the O2 SET-point cermet RV9 for full-scale deflection on the meter M1. Still in the SET mode adjust RY100 so that the voltmeter reading tends towards -2.5V, continue adjusting RV10 until the panel meter reads 1% away from full scale. Now alternatively adjust RV9 and RV10 until the panel meter reads 25% and the voltmeter reading is 2.5V, seal the cermet RV10.
7) Repeat the above on the CO_2 side adjusting RV5 and RV6 until the panel meter reads 20% and the voltage is 2V. Seal the cermet RV6.
8) Pass a sample of 20% CO_2 through the cells, monitor the voltage on the N/C contact of S2 if the voltage is positive, swap the two signal arms of the bridge. Adjust the SPAN cermet RV3 so that the meter reads 20%. Recheck that the voltage on the output BNC J3 is -2V.
9) Pass a sample of air through the cells and check that the voltage on S1 N/C contact is negative. If not swap the fuel cell wires. Adjust the SPAN cermet RV8 so that the O_2 meter reads 21%. Check that the voltage on the output BNC J2 is -2.1V.
10) Check the CO_2 light by setting the CO_2 SET-point to 1% and breathing into the cells the CO_2 OUTPUT light should turn on at $1\frac{1}{2}$% and off at $\frac{1}{2}$%.
11) Check the O_2 output light by setting the O_2 SET-point at 19, breathe out into the cells, the O_2 OUTPUT light should come on at 18.5% and off at 19.5%.

J1 Pin Connections

1	- CO_2 bridge green
2	+ CO_2 in brown
3	- CO_2 meter black
4	CO_2 out, $24V_{AC}$, blue
5	+ AC in $24V_{AC}$, yellow
6	- CO_2 output level, J.3. red
7	NC
8	+ O_2 output level, J2.0V green
9	+ O_2 meter orange
10	+ O_2 in yellow
11	O_2 out, $24V_{AC}$, Red
12	OV (transformer) green
13	7VRMS (transformer) blue
14	+ CO_2 bridge violet
15	- CO_2 in grey
16	+ CO_2 meter white
17	+ CO_2 light, $24V_{AC}$, blue
18	+ CO_2 output level, J3, OV green
19	NC
20	NC
21	- O_2 output level, J2 brown
22	- O_2 meter
23	- O_2 in OV green
24	- O_2 light, $24V_{AC}$, red
25	7VRMS orange

To understand the oxygen cycle the controller 12 in a manner readily appreciated by a person skilled in the art is connected to a pair of solenoid valves 15 and 16 which preferably operate in unison, i.e. they are simultaneously closed as depicted in Figure 3 or open as depicted in Figure 4. In the open condition as indicated in Figure 4 there is a positive infusion of air from outside of the container into the environment of the container via the port 15 and a displacement out of a corresponding amount via port 16. Such a positive infusion of outside air in order to raise the oxygen level is under the action of the fan 7 which provides the differential necessary. As shown in Figure 3 just upsteam of the fan the pressure is lower than downstream (denoted by the aud-ve respectively). Obviously once the controller 12 detects that the oxygen level is sufficiently high another threshold is met whereupon the valves 15 and 16 would close in unison.

A positive (i.e. forced) infusion of air is under the action of the pressure, positive or negative, on one side only of the evaporator or evaporator/fan assembly. The atmosphere can be exhausted from the container by opening the positive pressure side of the evaporator to the ambient atmosphere thus requiring air to be admitted to the container by the various leakage paths in the sealing system. Alternatively air from the ambient atmosphere can be admitted to the container by opening the low (-ve) pressure side of the evaporator to ambient atmosphere whereupon air is exhausted from the container by the various leakage paths in the sealing system.

In some models of shipping containers, the pressure differential across the evaporator/fan assembly of the refrigeration unit may be insufficient to provide a flow of sampling gas to and from the gas controller. An automatic sampling pump is then incorporated to provide the gas sample.

While the fan 7 can be used to cause the air movement in lieu of the fan 4 depicted in Figure 5 for the purposes of carbon dioxide scrubbing it may be simpler to provide a separate unit. In that case the carbon dioxide controller, for example 12, would actuate that fan to cause the scrubbing of the environmental gas by the hydrated lime and would stop the fan when an acceptable level has been reached. When the acceptable carbon dioxide level has been reached, the scrubber is sealed from the container atmosphere by valves 17 closing under the operation of the controller. Likewise when fan 4 is operating under the operation of the controller valves 17 open simultaneously.

A person skilled in the art will however appreciate how the carbon dioxide controller could instead control valved ports, for example, in a manner substantially as described in relation to the oxygen control so as to provide the necessary flow through a scrubbing medium for the carbon dioxide without the use of fan 4, but using the differential pressure due to fan 7.

The carbon dioxide sample may be obtained in some containers by using the gas sampling pump previously referred to.

Preferably the required passage of the environment at the dictates of the CO_2 monitoring or controlling system is by control of a fan, (if the pressure differential across the container refrigeration fan/evaporator unit is not employed), and or valves, which may be or may not be electrically operated, irrespective of whatever fan is employed).

The monitoring system for oxygen and carbon dioxide may also be a separate unit, transferable between containers, which may be attached to the container physically, with the requisite electrical and gas sampling connections.

It can be appreciated that the scrubbing procedure for controlling carbon dioxide is necessary since as a flushing system using ambient air is being employed to control the oxygen level a similar flushing system using ambient air can not be used for the control of the carbon dioxide level and for this reason the present invention also consists in the control of the carbon dioxide level within a closed environment employing a controller activated by carbon dioxide levels within the environment which activates a positive infusion of gas from the environment through a carbon dioxide scrubber and from there back into the environment.

On the basis of the foregoing therefore it can be seen that there is the prospect of a constant monitoring of the environment so as to enhance the freshness of vegetables or fruits, for example, asparagus, stone fruit, advocados, tamarillos, etc., or plants with above freezing refrigeration but for a sufficiently long period, for example, four to eight weeks to enable such produce to be freighted the distances involved from New Zealand.

In a preferred container in accordance with the present invention the degree of seal is such that the system can be controlled. As indicated in the the present invention the atmosphere control system depends for it successful operation on the conversion of oxygen to carbon dioxide by the cargo, all fresh fruit and vegetables breathe. The space within the sealed cargo system of the container is not completely airtight and is only partially so, air gets in to thereby cause a diffusion inwardly of oxygen and nitrogen and the internal atmosphere can also get out through any small leaks or indeed even by diffusion through the door sealing however since the leakage into the container allows less oxygen to pass in than the product "breathes" additional oxygen must be let in under control to maintain a specified or predetermined oxygen level. Thus there is provided a system capable of control. Similarly since the production of carbon dioxide is greater than the leakage out to atmosphere then the carbon dioxide must be removed to maintain a preset level. Thus again we have a system capable of control for optium activity therefore there is some need to balance the leak tightness of the sealed container relative to the product activity. In practice it has been found that a level of leak tightness suitable for a product with a low activity should be specified as it is applicable to all cargoes. It should be remembered however the higher the product activity the less gas tight the container has to be. With a view however to ensuring that containers can carry any type of fresh respiring produce a minimum leakage rate is being specified. The actual leakage rate in service over the many days transit time envisaged will also vary due to the ambient atmospheric pressure as leakage will vary with the pressure. Difference between the inside and outside of the substantially gas type space thus the leakage tests we use is not truly "absolute" but is adequate for practical purposes.

For trial purposes to determine the leakage rate of a container the container is fitted with a "Transfresh" doorseal, the defrost and air freshening apertures are sealed and the container is pressurised using compressed air or compressed nitrogen to 10.2 cm (4") water gauge pressure. This seats the door seal. The pressure within the container is then maintained using a manometer. The pressure within the container is increased to 10.2 cm (4") water gauge or above and the time taken for the pressure to drop to 5.1 cm (2") water gauge is measured. This provides a measure of the half life of pressure within the container and this decay time should not be below 5 minutes. To check the system against the actual leakage rate air can be pumped into or out of the container and the volume of air or nitrogen added or subtracted measured. This air flow can be adjusted to maintain a pressure or vacuum within the container of 1.3 cm ($\frac{1}{2}$") water gauge. Figure 6 shows plotted half life decay time (actual from 4" down to 2" water gauge) in minutes against the flow rate in cubic feet per hour (at $\frac{1}{2}$" water gauge and ambient temperature) which is the actual leakage rate. The preferred leakage characteristics for a 6.4 m (21') container is one having a decay time of above 5 minutes or a flow rate of less than 453 cubic litre (16 ft^3) per hour at 1.3 cm ($\frac{1}{2}$") water gauge.

For a standard 12.2 m (40') long ISO container (as opposed to 6.4 m (21') containers) a satisfactory leakage rate (at 1.3 cm ($\frac{1}{2}$") water gauge pressure within the container) is estimated to be preferably no more than 906 litres (32 ft^3) per hour. This should give a half life decay of no less than 3 minutes. Please note that Figure 6 relates to 6.4 m (21') ISO containers.

A person skilled in the art will appreciate that the system in accordance with the present invention, especially where both oxygen and carbon dioxide controls are employed have significant advantages over the incompletely controlled systems previously known.

Claims

1. A method of transporting a quantity of comestible which may be subject to degradation as a result of respiration during transportation in a container wherein the container with the respiring comestible therein is initially flushed to reduce the oxygen level in the container atmosphere, and the container is transported with the respiring comestible therein while monitoring the oxygen and carbon dioxide levels within said container and adjusting the oxygen level as necessary by a positive infusion of ambient air into the container in response to such monitoring towards an optimum or predetermined reduced value or range of reduced values and reducing the carbon dioxide level as necessary in response to such monitoring towards an optimum or predetermined value or range of values; characterised in that the container containing the quantity of respiring comestible is partially sealed to the extent necessary to ensure that less oxygen from the ambient air can diffuse into the container than is consumed by the respiring comestible, ambient air being allowed to flow into the container to provide an oxygen inflow at a higher rate than is immediately being consumed by the respiring comestible to increase the level of oxygen in the container when the level of oxygen is detected to be too low.

2. A method according to claim 1, wherein the degree of partial sealing is such that the half life of a pressure differential between the outside and the interior of the container is not less than five minutes for a 6.4 m (21') container or three minutes for a 12.2 m (40') container.

3. A method according to claim 1 or 2, characterised in that the oxygen content is adjusted to be in the range of 1% to 10% by volume.

4. A method according to claim 1, 2 or 3, characterised by monitoring the temperature within said container and adjusting the temperature as necessary in response to said monitoring towards an optimum or predetermined value or range of values.

5. A method according to claim 4, characterised in that the temperature is adjusted by refrigeration with the optimum or predetermined value or range of values being above the freezing point of the comestible.

6. A method according to any preceding claim characterised in that the carbon dioxide content is adjusted to be in the range of less than 10% by volume.

7. A method according to any one of the preceding claims characterised in that the step of flushing the container to reduce the oxygen level in the container atmosphere is carried out using a nitrogen-rich gas.

8. A method according to any one of the preceding claims characterised in that the comestible comprises plant matter, fruit matter, vegetable matter, or a combination of two or more of plant, fruit and vegetable matter.

9. A shipping container for use in the method of any preceding claim, including a monitoring system (12) for monitoring the oxygen and carbon dioxide content of the atmosphere within the container and means (7) automatically responsive to said monitoring system for providing a positive infusion of ambient air into the environment of the container in order to raise the oxygen content therein should it fall beyond a predetermined value, the monitoring system (12) also monitoring the carbon dioxide content of the atmosphere within the container

with means (2,8,4) being provided for automatically providing a scrubbing out of carbon dioxide from the atmosphere within the container when the carbon dioxide content rises above a predetermined value within the substantially sealed gas environment; characterised in that the container is provided with means for partially sealing it against the passage of gas such that the half life of a pressure differential between the inside and the outside of the container is not less than five minutes for a 6.4 m (21') container or three minutes for a 12.2 m (40') container whereby in use of the container less oxygen from the ambient air can diffuse into the container than is required for respiration by respiring comestible stored therein; and in that valve means are provided controlled by the monitoring means to allow an increased infusion of air into the container to provide an oxygen inflow greater than is immediately being consumed by the respiring comestible when the oxygen level drops too low.

10. A container as claimed in claim 9, characterised by a temperature monitoring system for the environment and/or atmosphere of the container and means (E,7) responsive to the monitoring system to lower the temperature by circulation of the gas in the container through the system (12) for monitoring the oxygen and carbon dioxide content of the atmosphere in the container.

Revendications

1. Procédé de transport d'une quantité de comestibles pouvant être sujets à des dégradations du fait de la respiration pendant le transport dans un conteneur, dans lequel le conteneur avec le comestible qui respire à l'intérieur est initialement purgé pour réduire le niveau de l'oxygène dans l'atmosphère du conteneur, et le conteneur est transporté avec le comestible qui respire à l'intérieur tout en surveillant le niveau de l'oxygène et du dioxyde de carbone dans ledit conteneur et en ajustant le niveau de l'oxygène selon les nécessités par une infusion positive d'air ambiant dans le conteneur en réponse à cette surveillance en visant une valeur ou une plage de valeurs réduite optimale ou prédéterminée et en réduisant le niveau du dioxyde de carbone en fonction des nécessités en réponse à cette surveillance en visant une valeur ou une plage de valeurs réduite optimale ou prédéterminée, caractérisé en ce que le conteneur contenant la quantité de comestible qui y respire est partiellement fermé de façon étanche dans la mesure nécessaire pour être sûr qu'une quantité d'oxygène provenant de l'air ambiant et inférieure à celle qui est consommée par le comestible qui respire puisse être diffusée dans le conteneur, l'air ambiant étant autorisé à s'écouler dans le conteneur pour déterminer une entrée d'oxygène selon un débit plus élevé que celui qui est immédiatement consommé par le comestible qui respire pour augmenter le niveau de l'oxygène dans le conteneur quand le niveau de l'oxygène est détecté comme étant trop bas.

2. Procédé selon la revendication 1, dans lequel le degré de fermeture étanche partielle est tel que la demi-durée de vie d'un différentiel de pression entre l'extérieur et l'intérieur du conteneur n'est pas inférieur à cinq minutes pour un conteneur de 6,4 m (21 pieds) ou de trois minutes pour un conteneur de 12,2 m (40 pieds).

3. Procédé selon la revendication 1 ou 2, caractérisé en ce que la teneur en oxygène est ajustée de manière à être comprise dans la plage de 1% à 10% en volume.

4. Procédé selon l'une quelconque des revendications 1 à 3, caractérisé par la surveillance de la température dans ledit conteneur et le réglage de la température dans la mesure où cela est nécessaire en réponse à ladite surveillance pour viser une valeur ou plage de valeurs optimale ou prédéterminée.

5. Procédé selon la revendication 4, caractérisé en ce que la température est réglée par réfrigération tandis que la valeur ou la plage de valeurs optimale ou prédéterminée est située au-dessus du point de congélation du comestible.

6. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que la teneur en dioxyde de carbone est réglée de manière à être dans la plage inférieure à 10% en volume.

7. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que l'étape de purge du conteneur pour réduire le niveau de l'oxygène dans l'atmosphère du conteneur est réalisée en utilisant un gaz riche en azote.

8. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que le comestible comprend des plantes, des fruits, des légumes ou une combinaison de deux ou plusieurs plantes, fruits ou légumes.

9. Conteneur d'expédition destiné à être utilisé dans le procédé selon l'une quelconque des revendications précédentes, comprenant un système de surveillance (12) pour surveiller la teneur en oxygène et dioxyde de carbone de l'atmosphère qui est à l'intérieur du conteneur et des moyens (7) qui répondent automatiquement audit système de surveillance pour déterminer une infusion positive d'air ambiant dans l'environnement du conteneur de manière à élever la teneur en oxygène qu'il contient si elle vient à baisser au-dessous d'une valeur prédéterminée, le système de surveillance (12) surveillant également la teneur en dioxyde de carbone dans l'atmosphère à l'intérieur du conteneur tandis que des moyens (2, 8, 4) sont prévus pour déterminer automatiquement l'élimination du dioxyde de carbone de l'atmosphère régnant dans le conteneur quand la teneur en dioxyde de carbone monte au-dessus d'une valeur prédéterminée dans l'environnement gazeux sensiblement enfermé de façon étanche, caractérisé en ce que le conteneur est muni de moyens pour le rendre partiellement étanche vis-à-vis du passage de gaz tels que la demi-durée de vie d'un différentiel de pression entre l'intérieur et l'extérieur du conteneur ne soit pas inférieure à cinq minutes pour un conteneur de 6,4 m (21 pieds) ou à trois minutes pour un conteneur de 12,2 m (40 pieds), ce grâce à quoi, quand le conteneur est utilisé, une quantité d'oxygène inférieure à celle qui est nécessaire à la respiration par le comestible qui respire et qui est stocké à l'intérieur peut se diffuser dans le conteneur, et en ce que des moyens à soupape sont prévus et commandés par les moyens de surveillance pour permettre une infusion plus importante d'air dans le conteneur et déterminer une entrée d'oxygène supérieure à celle qui est immédiatement consommée par le comestible qui respire quand le niveau de l'oxygène baisse trop fortement.

10. Conteneur selon la revendication 9, caractérisé par un système de surveillance de la température de l'environnement et/ou de l'atmosphère du conteneur et par des moyens (E, 7) répondant au système de surveillance pour abaisser la température par une circulation du gaz dans le conteneur par le système (12) prévu pour surveiller la teneur en oxygène et dioxyde de carbone de l'atmosphère à l'intérieur du conteneur.

Patentansprüche

1. Verfahren zum Transport von Eßwaren, die einen Qualitätsverlust infolge von Sauerstoffaustausch während des Transports in einem Container erleiden können, wobei der Container mit den darin befindlichen sauerstoffaustauschenden Eßwaren anfänglich gespült wird, um den Sauerstoffgehalt innerhalb der Containeratmosphäre zu senken, und in welchem der Container mit den darin angeordneten sauerstoffaustauschenden Eßwaren transportiert wird, während der Sauerstoff- und Kohlendioxidgehalt innerhalb des Containers überwacht und der Sauerstoffgehalt durch Einblasen von Umgebungsluft in den Container entsprechend der Überwachung im Falle der Notwendigkeit auf einen optimalen oder vorherbestimmten reduzierten Wert oder einen Bereich von reduzierten Werten festgelegt wird und der Kohlendioxidgehalt entsprechend der Überwachung notwendigerweise auf einen optimalen oder vorherbestimmten Wert oder einen Bereich von Werten reduziert wird,

dadurch gekennzeichnet,

daß der Container, der die sauerstoffaustauschenden Eßwaren enthält, teilweise bis zu einem notwendigen Maß abgedichtet ist, um sicherzustellen, daß weniger Sauerstoff von der Umgebungsluft in den Container eintreten kann als durch die sauerstoffaustauschenden Eßwaren verbraucht wird, wobei Umgebungsluft in den Container einfließen kann, um einen Sauerstoffzutritt in einem höheren Maß zuzulassen als er unmittelbar durch die sauerstoffaustauschenden Lebensmittel verbraucht werden kann, um den Sauerstoffgehalt innerhalb des Containers für den Fall zu erhöhen, daß er als zu niedrig gemessen wird.

2. Verfahren nach Anspruch 1, in welchem der Grad des teilweisen Abdichtens so gewählt ist, daß die Halbwertszeit des Druckunterschiedausgleichs zwischen der Außenseite und der Innenseite des Containers nicht kleiner als 5 Minuten für einen 6,4 m (21') Container und nicht kleiner als 3 Minuten für einen 12,2 m (40') Container ist.

3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der Sauerstoffgehalt in einem Bereich von 1Vol.% bis 10Vol.% festgelegt ist.

4. Verfahren nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß die Temperatur innerhalb

des Containers überwacht und im notwendigen Maß entsprechend der Überwachung auf einen optimalen, oder vorherbestimmten Wert oder einen Bereich von Werten festgelegt wird.

5. Verfahren nach Anspruch 4, dadurch gekennzeichnet, daß die Temperatur beim Kühlen auf einen optimalen oder vorherbestimmten Wert oder einen Bereich von Werten festgelegt ist, der oberhalb des Gefrierpunktes der Eßwaren liegt.

6. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Kohlendioxidgehalt in einem Bereich von weniger als 10Vol.% eingestellt wird.

7. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Schritt des Spülens des Containers zur Reduzierung des Sauerstoffgehalts innerhalb der Containeratmosphäre unter Verwendung von stickstoffreichem Gas ausgeführt wird.

8. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Eßwaren Pflanzen, Früchte, Gemüse oder eine Kombination von zwei oder mehr der Pflanzen, Früchte und Gemüse umfassen.

9. Transportcontainer für das Verfahren nach einem der vorhergehenden Ansprüche mit einem Überwachungssystem (12) zur Überwachung des Sauerstoff- und Kohlendioxidgehalts der in dem Container befindlichen Atmosphäre und Mitteln (7), die automatisch mit diesem Überwachungssystem zusammenwirken, um Umgebungsluft ins Containerinnere einzublasen, um darin den Sauerstoffgehalt für den Fall zu erhöhen, daß er unter einen vorherbestimmten Wert fällt, wobei das Überwachungssystem (12) auch den Kohlendioxidgehalt der Atmosphäre innerhalb des Containers mit Mitteln (2, 8, 4) überwacht wird, die derart ausgestaltet sind, daß sie ein Auswaschen von Kohlendioxid aus der Atmosphäre innerhalb des Containers für den Fall bewirken können, wenn der Kohlendioxidgehalt über einen vorherbestimmten Wert innerhalb der im wesentlichen abgedichteten Gasumgebung steigt,

dadurch gekennzeichnet,

daß der Container mit Mitteln zu einem teilweise gasdichten Verschließen in der Weise ausgestattet ist, daß die Halbwertszeit eines Druckunterschiedausgleichs zwischen der Innenseite und Außenseite des Containers nicht geringer als 5 Minuten für einen 6,4 m (21') Container und nicht geringer als 3 Minuten für einen 12,2 m (40') Container ist, wobei während des Betriebs dieses Containers weniger Sauerstoff von der Außenluft in den Container eindifundieren kann als es für den Sauerstoffaustausch durch die sauerstoffaustauschenden Eßwaren, die darin angeordnet sind, benötigt wird, und daß durch das Überwachungssystem gesteuerte Ventile vorgesehen sind, um einen ansteigenden Luftstrom in den Container einzulassen, um einen einströmenden Sauerstoffstrom bereitzustellen, der größer ist als der unmittelbar von den sauerstoffaustauschenden Eßwaren benötigte Sauerstoffstrom, wenn der Sauerstoffgehalt auf einen zu niedrigen Wert absinkt.

10. Container nach Anspruch 9, gekennzeichnet durch ein Temperaturüberwachungssystem für die Umgebung und/oder Atmosphäre des Containers und Mittel (E, 7) in Zusammenwirkung mit dem Überwachungssystem, die dazu dienen, die Temperatur durch Gaszirkulation innerhalb des Containers durch das System (12) zur Überwachung des Sauerstoffs und des Kohlendioxydgehalts der Atmosphäre in dem Container zu senken.

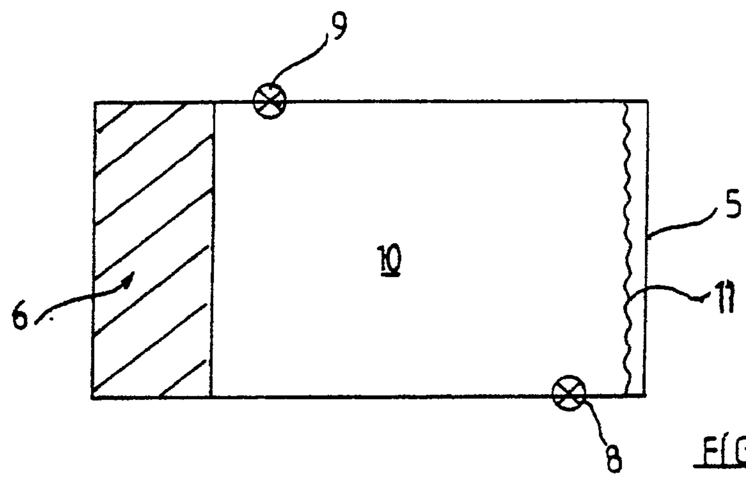

FIG.1.

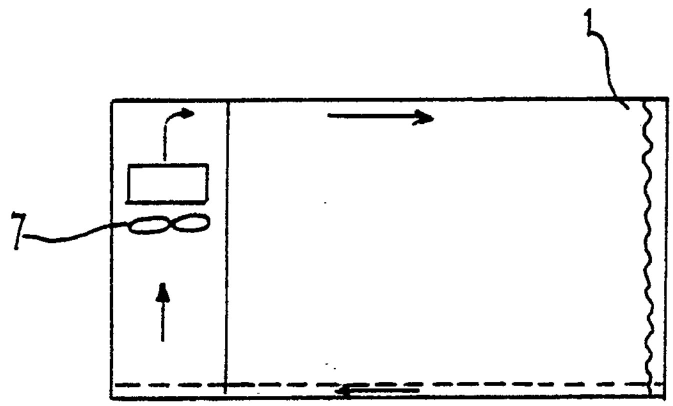

FIG.2B.

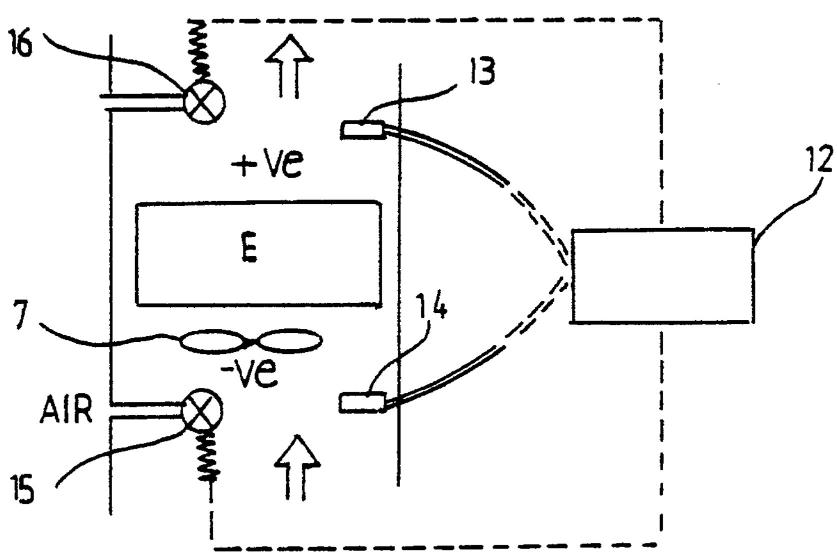

FIG.3.

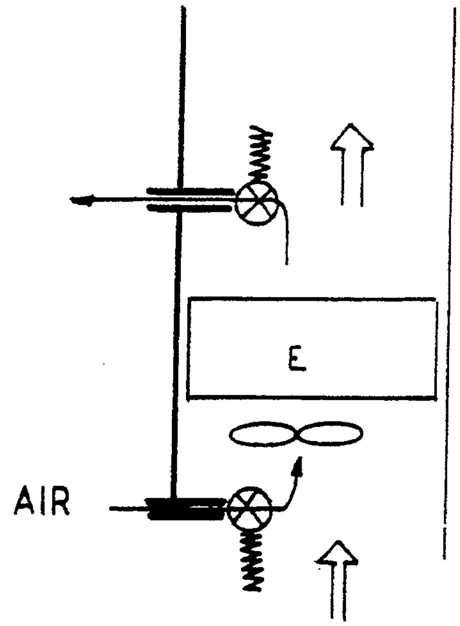

FIG 4

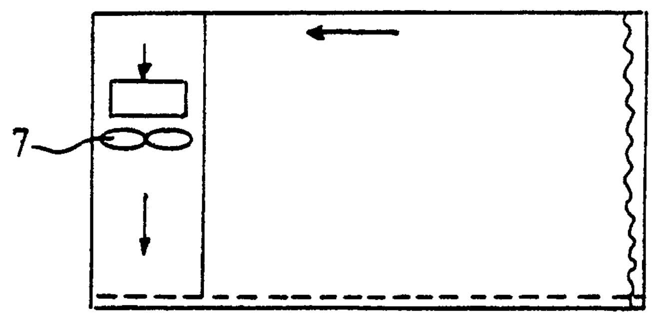

FIG 2A

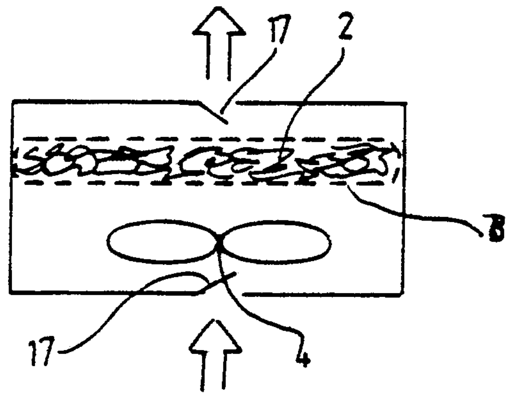

FIG 5

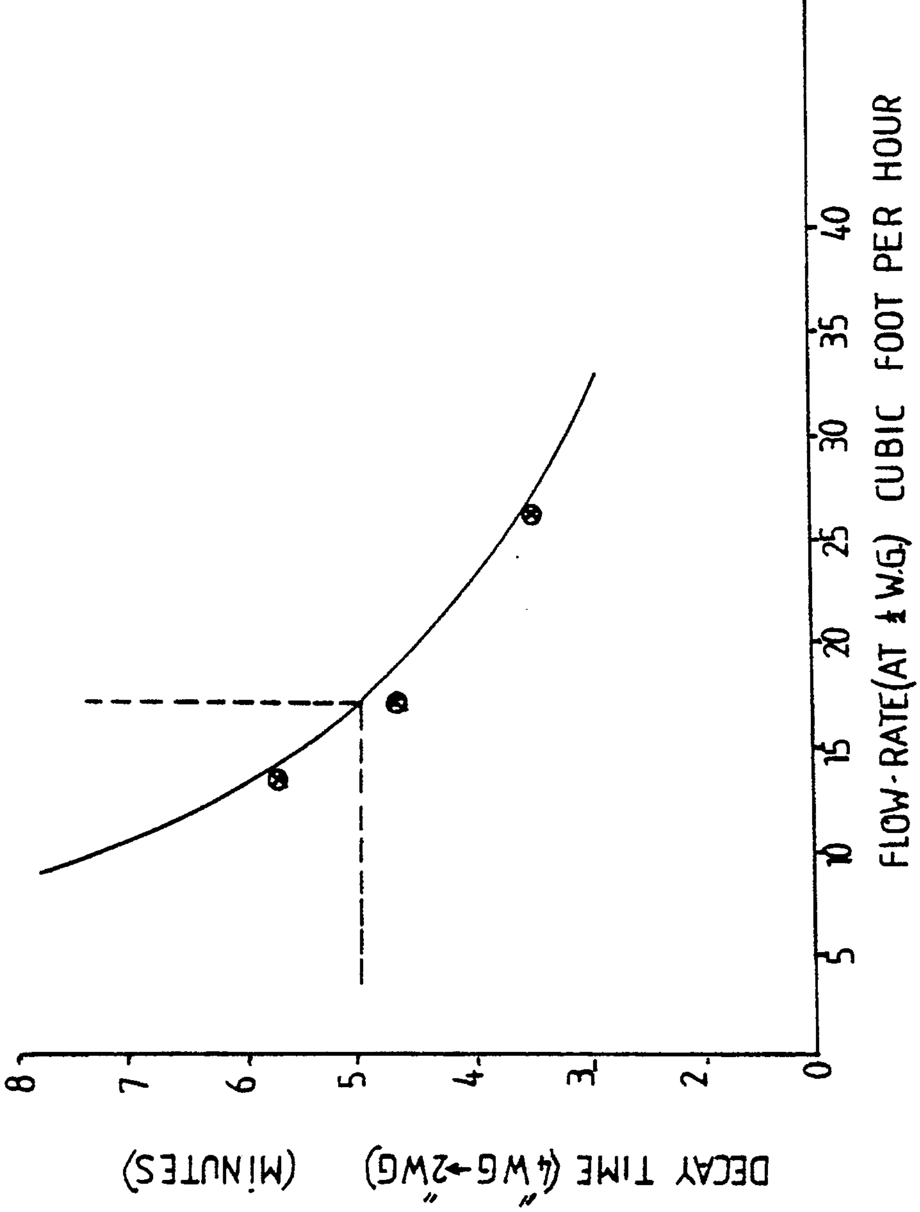
FLOW-RATE(AT ¼ W.G.) CUBIC FOOT PER HOUR
5
10
15
20
25
30
35
40
DECAY TIME (4"WG→2"WG) (MINUTES)
0
2
3
4
5
6
7
8

FIG 6

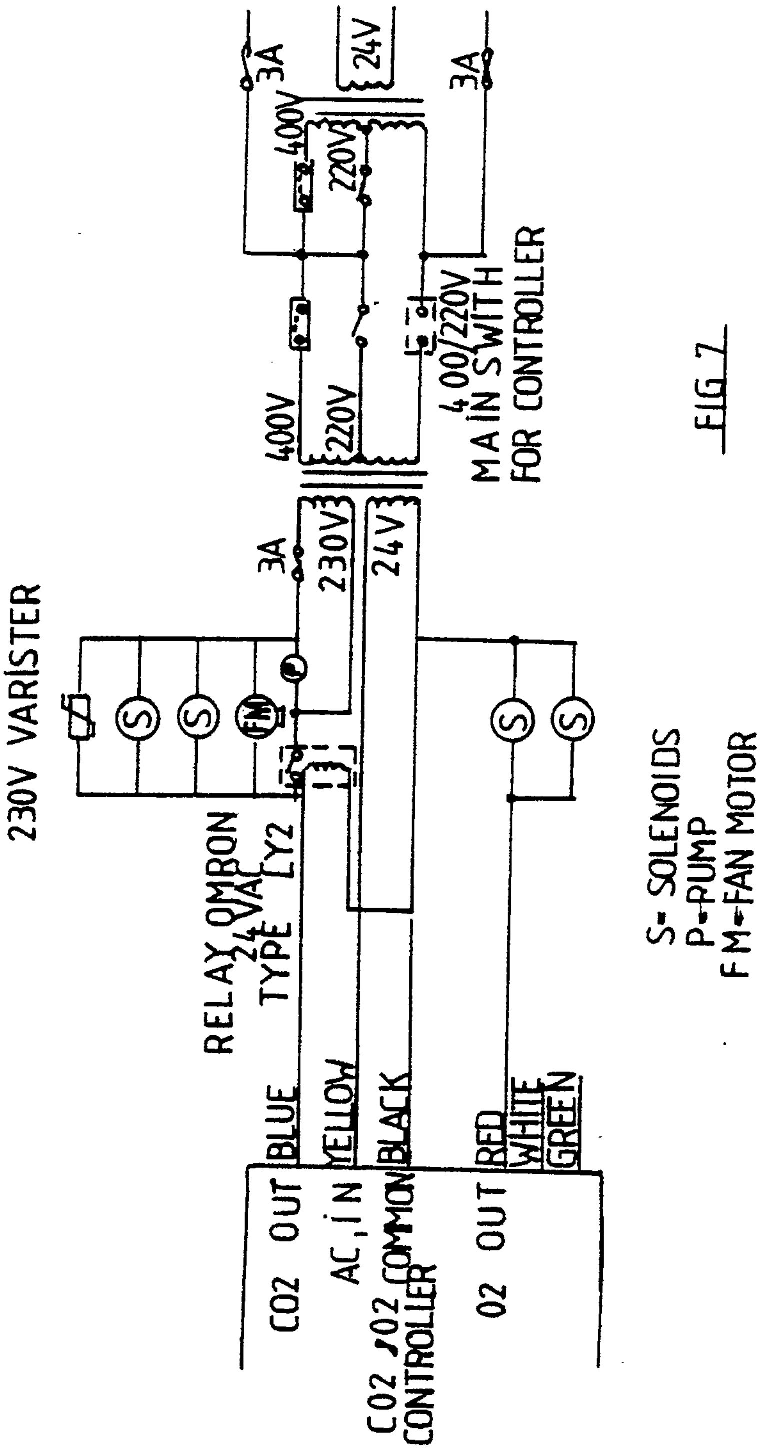
230V VARISTER
RELAY OMRON 24 VAC TYPE LY2
3A
230V
24V
400V
220V
400V
220V
3A
24V
3A
400/220V MAIN SWITH FOR CONTROLLER
BLUE
YELLOW
BLACK
RED
WHITE
GREEN
CO2 OUT
AC, IN
CO2 /O2 COMMON
O2 OUT
CO2 /O2 CONTROLLER
S= SOLENOIDS
P=PUMP
FM=FAN MOTOR

FIG 7

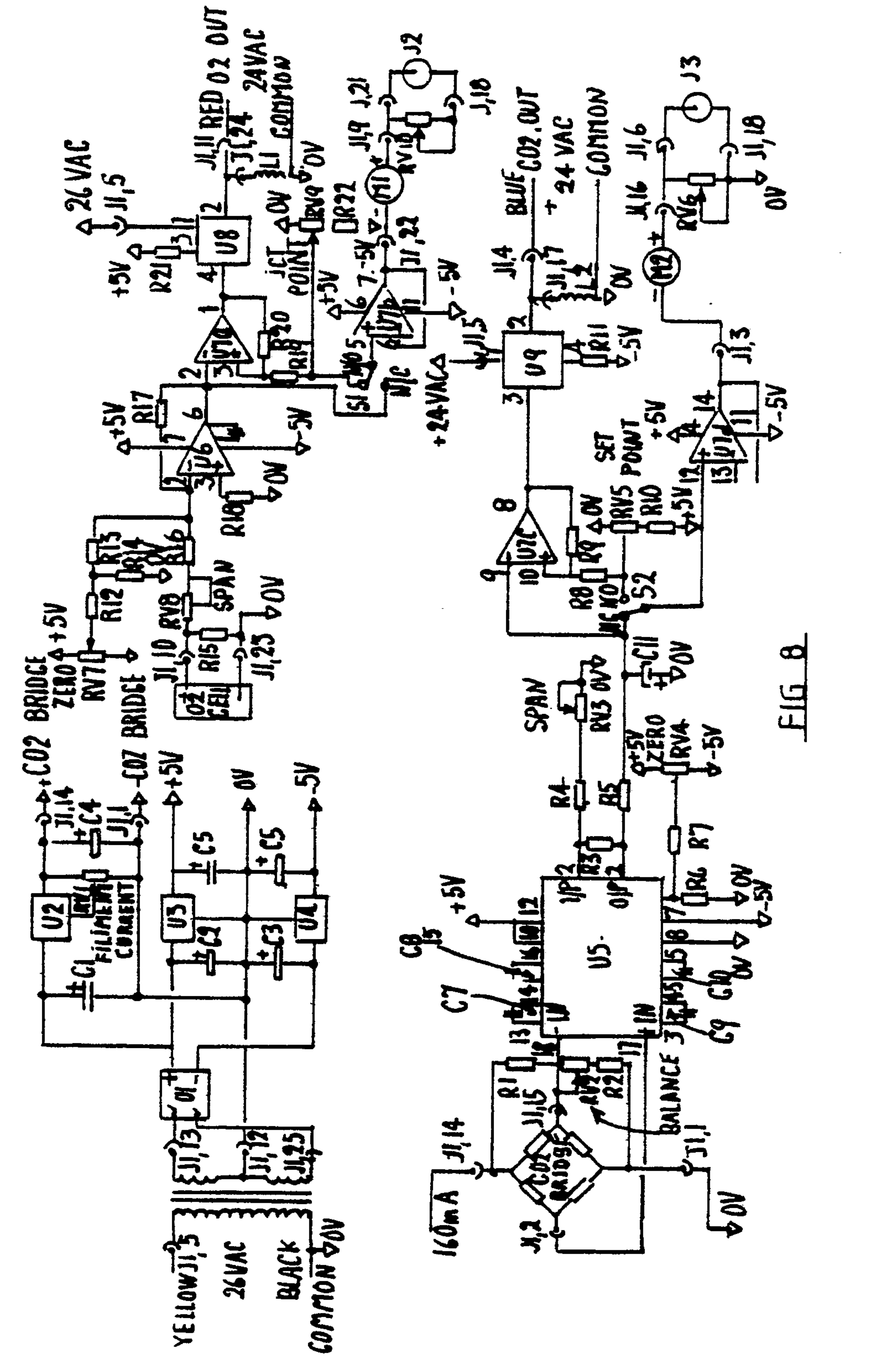

FIG 8

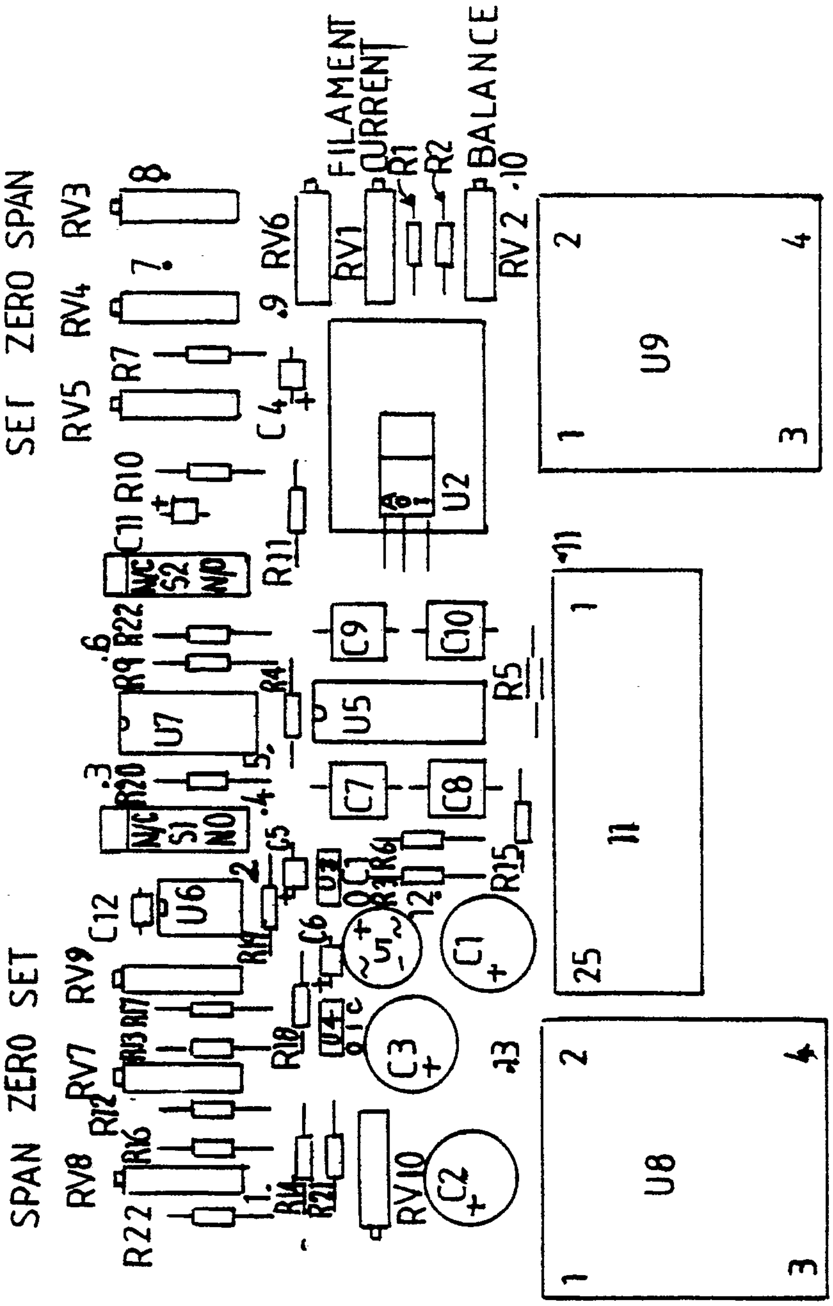
SPAN ZERO SET
SET ZERO SPAN
FILAMENT CURRENT
BALANCE
RV8
RV7
RV9
RV5
RV4
RV3
RV6
RV1
RV 2
RV10
R22
C12
U6
S1
N/C
NO
S2
N/O
U7
U5
C11
R10
R7
C4
R11
R1
R2
U2
U9
U8
C7
C8
C9
C10
R5
R15
C1
C2
C3
C5
C6
R18
25
11

FIG. 9.

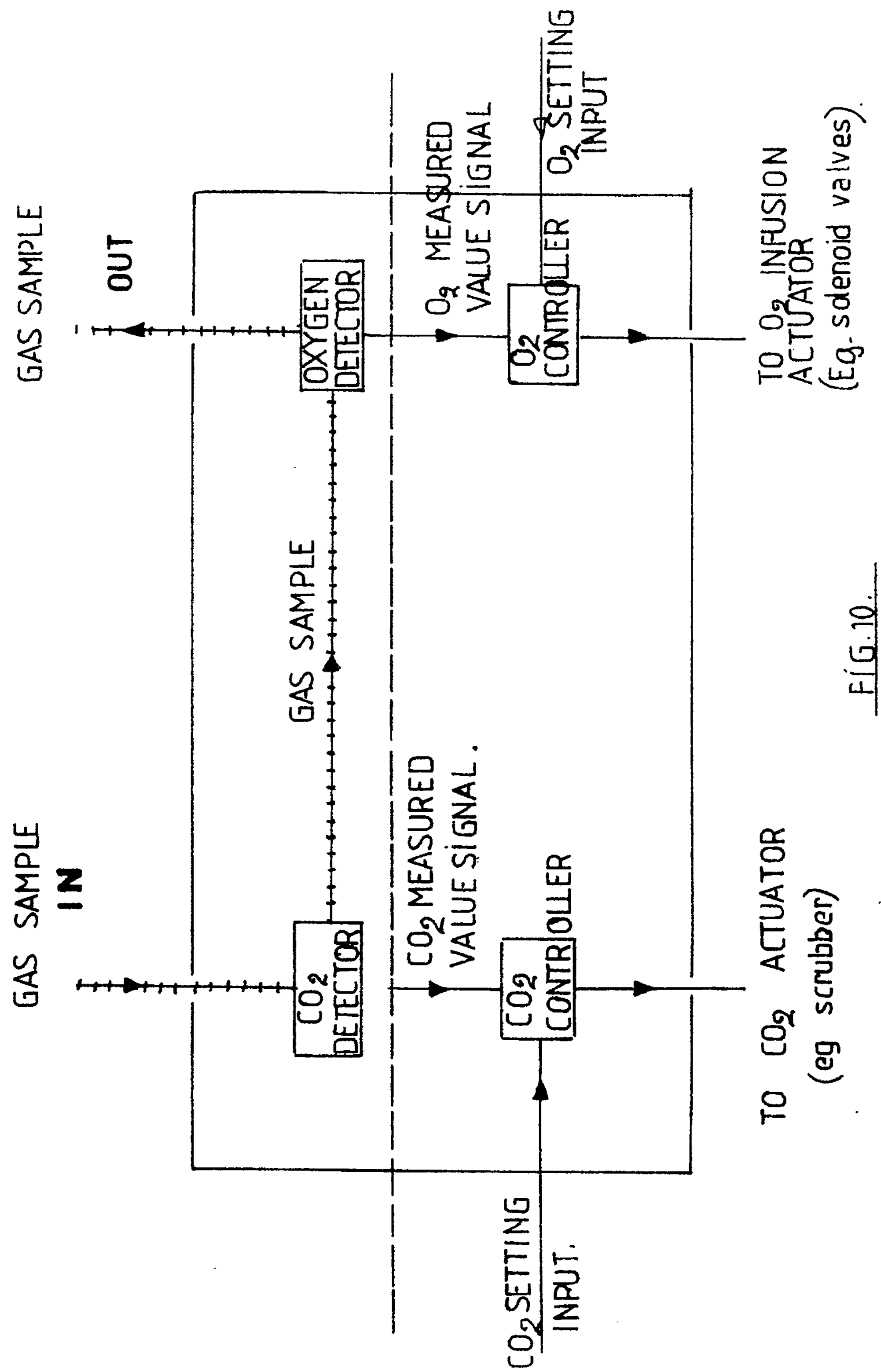
GAS SAMPLE
IN
GAS SAMPLE
OUT
CO2 DETECTOR
OXYGEN DETECTOR
GAS SAMPLE
CO2 MEASURED VALUE SIGNAL.
O2 MEASURED VALUE SIGNAL
CO2 CONTROLLER
O2 CONTROLLER
O2 SETTING INPUT
CO2 SETTING INPUT.
TO CO2 ACTUATOR (eg scrubber)
TO O2 INFUSION ACTUATOR (Eg. sdenoid valves).

FIG.10.